

Crack Detection of Medical Bone Image Using Contrast Stretching Algorithm with the Help of Edge Detection

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Abstract: The purpose of this project is to find out the accuracy of an X-Ray Detection of crack Bone using Canny Edge Detection Method. Cracked bone is a bone condition that suffered a breakdown of bone integrity. Normally, bones have elasticity and a great number of strength. Crack in the Bone only happen when the bones took a force beyond their elasticity or strength. Canny Edge Detection method is an optimal edge detection algorithm on determining the end of a line with changeable threshold and less error rate. The proposed algorithm simulate on MATLAB 12-b and results have shown how canny edge detection can help determine location of crack in the bone.

Keywords - Histogram Equalization ,Image Enhancement , Edge Detection, Frequency Domain Analysis, Automatic Crack Detection of Bone.

Introduction

Pictures are the most common and convenient means of conveying or transmitting information. A picture is worth a thousand words. Pictures concisely convey information about positions, sizes and inter-relationships between objects. They portray spatial information that we can recognize as objects. Human beings are good at deriving information from such images, because of our innate visual and mental abilities. About 75% of the information received by human is in pictorial form. Medical image processing is a field of science that is gaining wide acceptance in healthcare industry due to its technological advances and software breakthroughs.

It plays a vital role in disease diagnosis and in improved patient care. Medical imaging is concerned with the development of the imaging devices that help to identify different aspects of the tissue and organs based on various properties and reveal new properties of the tissue and internal structure.

Wilhelm Roentgen discovered the existence of x-rays in 1895, Image analysis in medical field has advanced at a tremendous rate & has become the initial diagnostic tool in modern healthcare. X-ray is the oldest and most frequently used method which is painless and more economical.

It also helps medical practitioners during decision making with regard to the type of treatment. A crack bone is defined as a disruption in bone continuity. The degree of disruption can vary from a crack in the cortex to multi fragmentation. Bone crack are often associated with local tissue trauma. Small crack in bone are common, and most people will sustain one across a lifetime. There is a typical incidence, childhood, young adulthood and in the elderly.

Histogram Equalization

This method usually enhance the global contrast of so many images, especially when the usable axioms of the image is personify by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This is grant for region of lower local contrast to gain a higher contrast. Histogram equalization achieves this by effectively spreading out the most frequent intensity values.

The arrangement is useful in images with backgrounds and foregrounds that are both bright or both dark. Particularly about the method can lead to better views of bone structure in x-ray images, & to more detail in photographs that are over or under-exposed. One of the important advantage of the method is that it is a clearly straight forward technique and reverse operator. If the histogram equalization function is known, then the original histogram can be recovered. The calculation is not so complicated. A disadvantage of the method is that it is assorted. It may be possible that extend the contrast of background noise, while decreasing the valuable signal. Now a days in scientific imaging where spatial correlation is more important than intensity of signal, the small SNR ratio usually restrict visual detection.

Histogram equalization often produces unrealistic effects in photographs, however it is very useful for scientific images like thermal, satellite or x-ray images.

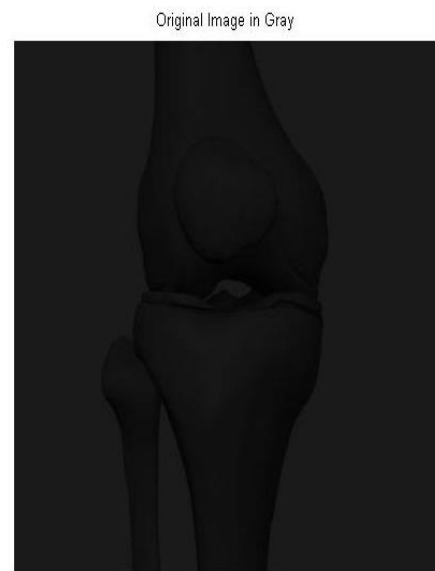


Fig.1 Tibia Bone In Gray Form

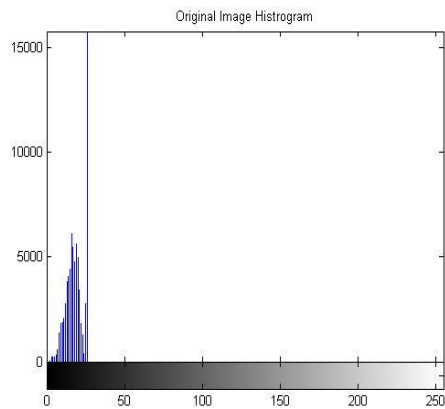


Fig.2 Histogram of Tibia Bone

Here Fig.(1) shows x-ray of tibia bone which is the input image in gray form having some noise while Fig.(2) semblance the histogram of tibia bone. Graph clearly give statistical information about tibia bone. Histogram are nothing but the graph between frequency of the image & intensity of the pixel. Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase in this. There may be some cases were histogram equalization can be worse. In that case the contrast is decreased.

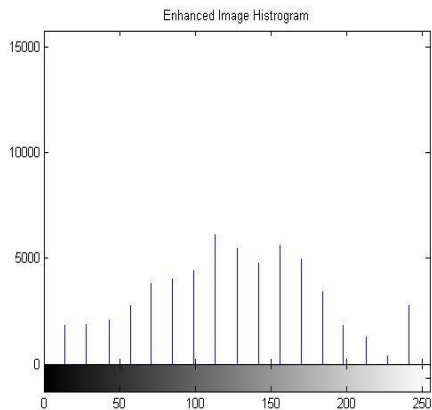


Fig.3 Histogram of Enhanced Image

Enhanced Image in Gray

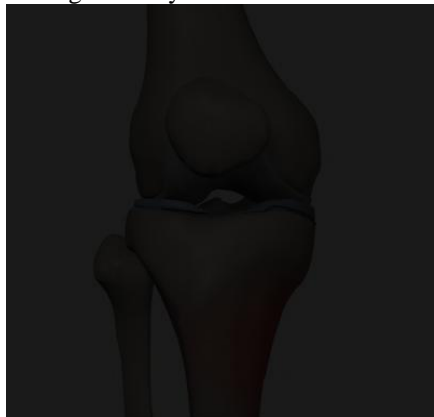


Fig.4 Enhanced Image of Tibia Bone

Fig.(3) Demonstrate the histogram of enhanced image where the intensity of the pixel are adjust up to 250 which is the root cause of the enhancement. There are two ways to think about and implement histogram equalization, either as image change or as palette change. The operation can be expressed as $P(M(I))$ where I is the original image, M is histogram equalization mapping operation and P is a palette. If we define a new palette as $P'=P(M)$ and leave image I unchanged then histogram equalization is implemented as palette change. On the other hand if palette P remains unchanged and image is modified to $I'=M(I)$ then the implementation is by image change. In most cases palette change is better as it preserves the original data. As you can clearly see from fig.(4) that the new image contrast has been enhanced and its histogram has also been equalized. There is also one important thing to be note here that during histogram equalization the overall shape of the histogram changes, where as in histogram stretching the overall shape of histogram remains sam

Edge Detection

Edge detection is method which aim to identify points in a digital image at which the image brightness vary keenly, has broken. The points at which image brightness vary keenly are emblematically organized into a set of curved line segments termed edges.

There are mainly four type of Edge Detection

- Canny Edge Detection
- Sobel Edge Detection
- Prewitt Edge Detection
- Robert Edge Detection

Canny was developed by John F. Canny in 1986. The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. Edges are considered to be most important image attributes that provide valuable information for human image perception. Edge detection is a very complex process affected by deterioration due to different level of noise. An edge is the boundary between an object and the background. Edge detection is identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. Canny is one of modern edge detection method that founded by Marrdan Hildreth, who is doing research in modeling human visual perception. There are several criteria on edge detecting that can be fulfilled by **Canny Edge Detection:**

1. Canny has better detection (for detection criteria). Canny method capable to marks all existing edges matching with user determined parameter's threshold. Also giving high flexibility on determining thickness level of edge detection according to the required conditions.

2. Canny has better localizing way (localize criteria). Canny capable on producing minimum gap between detected edge and the real image edge.

3. Obvious response (response criteria). Only one response for every edge. This make less confusion on edge detection for the next image. Choosing parameters on Canny Edge Detection will giving effect on every result and edge detection.

The following is the steps to do Canny Edge Detection.

- I. Remove all noise on the image by implementing Gaussian Filter. The result is an image with less blur. It is intended to obtain the real edges of the image. If we did not apply the Gaussian Filter before, sometimes the noise itself will be detected as an edge.
- II. Detect the edge with one of these detection operators, like Roberts, Prewitt, or Sobel by doing horizontal searching (G_x) and vertical searching (G_y). The following is the sample of edge detection operator (Sobel operators).

(a) For X-Direction (b) For Y-Direction

, Figure. Sobel Operator (a) G_x , (b) G_y

The result from both operators combined to obtain the summary of vertical edge and horizontal edge with this formula

$$[G] = [G_x] + [G_y]$$

III Determining direction of the edge by using the following formula:

$$\text{Edge Gradient}(G) = \sqrt{G^2x + G^2y}$$

$$\theta = \arctan\left(\frac{G_y}{G_x}\right)$$

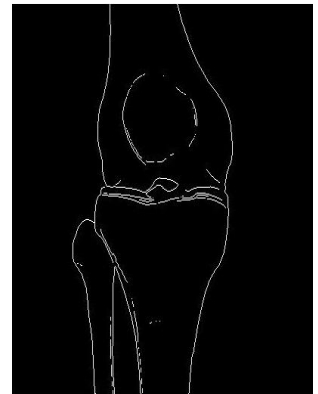
Canny Edge Detection using two thresholds (maximum threshold and minimum threshold). If pixel gradient higher than maximum threshold, pixel will be marked as an edge. If the pixel gradient lower than minimum threshold, the pixel will be denied as background image. If the pixel gradient between maximum threshold and minimum threshold, the pixel will be accepted as an edge if it is connected with other edge pixel that higher than maximum threshold

IV Minimize the emerging edge line by applying non maximum suppression. This process will give slimmer edge line.

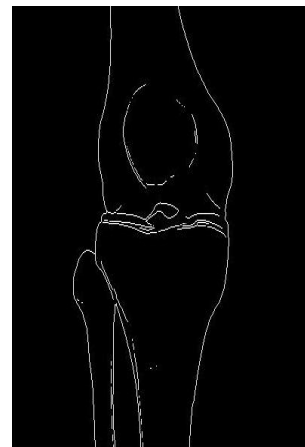
V The last step is binarizing the image pixels by applying threshold value.



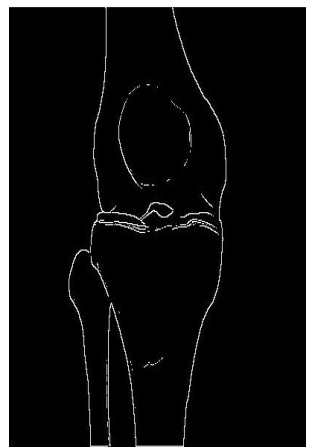
(A) Canny Edge Detection



(B) Sobel Edge Detection



(C) Prewitt Edge Detection



(D) Robert Edge Detection

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Fig.5 Edge Detection On Tibia Bone

$$\begin{bmatrix} 1 & 2 & 2 & 1 \\ 1 & 1 & 0 & 3 \\ 2 & 4 & 1 & 5 \\ 2 & 1 & 2 & 0 \end{bmatrix}$$

- Consider a matrix A with size of 3x3

$$\begin{bmatrix} 1 & 2 & 2 \\ 1 & 1 & 0 \\ 2 & 4 & 1 \end{bmatrix}$$

- Find the x-direction derivative : subtract the first row from third row using the mask.

$$G_x = (z_7 + z_8 + z_9) - (z_1 + z_2 + z_3)$$

$$G_x(1,1) = (2 + (2*4) + 1) - (1 + (2*2) + 2)$$

- Find the y-direction derivative : subtract the first column from third column using the mask.

$$G_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7)$$

$$G_y(1,1)=(2+(2*0)_+1)-(1+(2*1)_+2)=-2$$

- Find the Gradient :

$$G_x^2=16, G_y^2=4$$

$$\Delta f = [16+4]^{1/2} = [20]^{1/2}, \text{ i.e. } f(1,1)=4.4721.$$

The procedure is done for the whole image matrix.

IV. Frequency Domain Analysis

Under the frequency domain analysis there are three main tools which is DFT, FFT, Removal of Noise. These parameter are used for giving smoothing effect, removing the noise from the image.

a. DFT (Discrete Fourier Transformation)

For obtaining DFT six notch filter are used here such as [H1, H2, H3, H4, H5, H6] each having different value then calculated DFT is store in a particular variable let us consider F {i.e. F=DFT}

b. FFT (Fast Fourier Transformation)

To evaluating FFT again six notch filter are used same which are use in DFT each having different value from one another now calculated FFT is store in a particular variable let us consider FS.

$$\text{Since } FS = F * (H1 * H2 * H3 * H4 * H5 * H6)$$

c. Removal of Noise

After performing DFT & FFT operation still some noise is present in the image to removing this noise median filter [5,5] is useful because it gives convenient output image.

V. Automatic Crack Detection of Bone

We are using Contrast Stretching algorithm for detecting the crack on the bone Contrast stretching is a simple image enhancement technique that attempts to improve the contrast in an image by stretching the range of intensity values it contains to span a desired range of values, e.g. the full range of pixel values that the image type concerned allows. It differs from the more sophisticated histogram equalization in that it can only apply a linear scaling function to the image pixel values. As a result the 'enhancement' is less harsh. Contrast Stretching is a simple piecewise linear transformation functions which expands the range of intensity of the image to user defined span.



Fig.6 Automatic Crack Detection of Tibia Bone

Fig.(6) shows the crack on Tibia bone. The contrast of an image is a measure of its dynamic range, or the spread of its histogram. The dynamic range of an image is defined to be the entire range of intensity values contained within an image, The contrast of an image is a measure of its dynamic range, or the "spread" of its histogram. The dynamic range of an image is defined to be the entire range of intensity values contained within an image.

V. Conclusion

The proposed method is much better with both parametric and visual quality when compared to other state of the art methods. The image is analyzed by both the regular Histogram Equalization technique and contrast stretching algorithm by using the functions and instructions of MATLAB 12-b. It is observed that the image enhanced by contrast stretching algorithm has better clarity and definition. This algorithm with the help of image enhancement techniques can give high definition images. It evolves the enhancement of photographs, special effects in medical field. Thus image processing is used in every computer application which yields more accurate results. This is a rapidly growing field & has a very wide scope.

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